PUBLIC SERVICE COMMISSION
STATE OF WISCONSIN

Renewable Energy Resources

This overview contains information that will be useful to people who have an interest in the role of renewable energy resources in Wisconsin's electrical generation mix.

Renewable Energy

"Renewable energy" refers to energy that is continuously replenished by natural processes. State law (Wis. Stat. § 196.378(1)) defines the following as renewable energy:

- **Fuel Cell fueled by hydrogen**:
  - Reformed from ethanol produced by the fermentation and distillation of a grain
  - Reformed from ethanol produced from a biomass source as defined below
  - Reformed from any other biomass-derived fuel as defined below
  - Electrolyses of water energized by electricity generated from any of the sources listed below
- **Tidal or Wave Action**, energizing a facility by the action of tides or waves on a body of water
- **Solar Thermal**, using the sun's energy to heat a fluid that drives a turbine or heat engine to provide energy to a conventional electric generator
- **Photovoltaic (PV)**, a system that directly converts sunlight into electric power
- **Wind Power**, using the kinetic energy of the wind to produce electric power
- **Geothermal**, using the internal heat of the earth to generate electricity
- **Biomass**, energy derived from wood or plant material residue, biological waste, crops grown for use as a resource or landfill gases. Biomass does not include garbage or nonvegetation-based industrial, commercial or household waste
- **Hydroelectric**, a **facility** that uses the energy of running water to produce electric power

Advantages and Disadvantages of Renewable Resources

The advantages of renewable resources include:

- Low or no fuel cost (except for some biomass)
- Short lead-times for planning and construction
- Relatively small, modular plant sizes
- Reduced environmental effects compared to fossil fuels
- Non-depletable resource base
- Potentially more job intensive
- Favorable public opinion
- Distributed generation potential

The disadvantages include:

- Public concern for land use, biodiversity, birds, and aesthetics
- Relatively high capital cost
- Uneven geographic distribution
- Intermittent availability of some resources
- Lack of maturity or commercial availability of technologies
- Environmental issues with fuel supply (biomass)

Utilities and independent power producers are researching ways to expand the use of renewable resources. One of the most important benefits of renewable resources is their long-term availability. The other important benefit is their minimal impact to the atmosphere. These technologies are not been associated with mercury emissions or the causes of acid rain.

As of 1994, Wisconsin state law mandates that, "It is the goal of the state that, to the extent that is cost-effective and technically feasible, all new installed capacity for electric generation in the state be based on renewable energy resources, including hydroelectric, wood, wind, solar, refuse, agricultural and biomass energy resources."

In October 1999, Reliability 2000 (R2K) was passed. This legislation establishes a Renewable Portfolio Standard for Wisconsin. The Renewable Portfolio Standard phases in over ten years and requires that any utility providing retail electricity provide 2.2 percent of its energy from a renewable resource by December 31, 2011. A governor's task force has recently recommended that the Renewable Portfolio Standard for Wisconsin be increased to 10 percent by 2015.

Wind Energy

Electric power from the wind

Wind energy is converted to electricity when wind passes by blades designed like those of an airplane propeller mounted on a rotating shaft. As the wind moves the blades, the rotation of the shaft turns a generator which produces electricity.

Three factors affect wind machine power; the length and design of the blades, the density of the air, and wind velocity. Longer blades produce more power output. Cold air is denser than warm air, which means it produces more force, or ability to turn the blades (approximately 20 percent more). Also, in general, as elevations increase, wind turbines will encounter greater wind velocities.

Working with Public Service Commission (PSC) staff and the Department of Administration (DOA), Division of Energy, Wisconsin electric utilities have established a comprehensive statewide wind resource assessment program (WRAP). This program was ordered by the PSC to encourage wind power development in those areas of the state with the best wind energy potential. For a three-year period, wind speed and direction will be recorded at 13 sites and at 10, 25, 40, and 60 meter elevations. The information from WRAP is available to the public through the DOA, Division of Energy at alex.depillis@doa.state.wi.us.

There are currently five utility-scale wind farms in Wisconsin.

- Montfort Wind Farm (Dodge County) with a capacity of 30 megawatts (MW)
- Madison Gas and Electric Company Wind Farm (Kewaunee County) with a capacity of 11.22 MW

- Wisconsin Public Service Corporation Wind Farm (Kewaunee County) with a capacity of 9.24 MW
- Glenmore Project (Brown County) with two 600 kilowatt (kW) facilities
- Wisconsin Electric Power Company- Byron Project (southeast Wisconsin) with two 660 kW facilities

Approximately 400 MW of additional wind power is currently being proposed for the state of Wisconsin.

Environmental advantages associated with wind energy

Wind energy can have both positive and negative impacts on the environment. One of the major benefits of this technology is that it does not create air pollution. Power plants that burn coal, for example, emit sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon dioxide (CO_2), particulates, and heavy metals into the atmosphere. Natural gas-fired power plants emit NO_x and CO_2. Emissions from fossil-fuel-burning power plants contribute to acid rain damaging lakes, streams, and forests, ozone formation affecting human health, and global warming.

Because wind generated electricity does not use water, potential negative impacts such as thermal pollution of water bodies and impacts to surface waters and groundwater is avoided. Wind energy does not create solid waste, avoiding the issues connected with the transportation, treatment, and storage of these wastes.

From a social and economic standpoint, wind power has several advantages. Wind energy generally requires a larger workforce than typical combustion technologies. A 1992 study by the New York State Energy Office showed that on a watt for watt basis, wind power creates 66 percent more jobs than natural gas-fired generation and 27 percent more jobs than coal-fired electricity generation. Because wind power requires no fuel, the cost of wind-generated electricity is not affected by volatility in fuel prices.

Environmental disadvantages associated with wind energy

The risk of avian mortality is one of the major environmental problems associated with wind energy. Bird collisions with turbine blades and towers have been reported in this country and in Europe. Hawks, falcons, and eagles are commonly mentioned in the scientific literature as being susceptible to mortality from collision with wind turbines. However, smaller birds and bats may also be at risk. This issue has become rather controversial and is the subject of increasing study. Avian impacts associated with wind turbines are currently being studied in California, Wyoming, Spain, the Netherlands, England, and Scandinavia. Studies are also being conducted in Minnesota and Wisconsin.

Impacts to birds and bats can be reduced with careful siting of facilities. The PSC, in cooperation with electric utilities, other state and federal agencies, and environmental groups, is developing wind energy siting guidelines using Geographic Information System (GIS) technology. The siting guidelines and information resources developed from this project will identify areas where there are biological concerns in Wisconsin and combine this information with wind speed data from the on-going Wind Resource Assessment Program. This information will then be used as a guide for achieving environmentally sensitive siting of wind energy facilities.

Biomass Energy

Biomass energy is the release of energy stored in recently grown plant materials as opposed to fossil fuels such as coal or natural gas. Biomass can be burned like coal to produce steam. More common biomass fuels include waste wood and dedicated crops. Waste wood may come from construction projects, demolition projects, or as a waste from wood product manufacturing. It is the most available source of biomass in Wisconsin.

Currently, waste wood is burned in several generating plants in Wisconsin, including a few utility-owned plants, to produce steam for both electric energy and industrial processes. (This dual use of the steam is known as "cogeneration.") In some cases, the wood is burned along with coal, to reduce coal emissions, in a process known as "co-firing."

The amount of wood that can be co-fired with coal is different for different types of coal plant. Conversion of a coal plant to co-firing with biomass requires changes to that plant's boiler and its fuel handling process. A reliable supply of biomass fuel also must be guaranteed. The biomass supply for facilities burning only biomass would need to be much greater than the supply needed for co-firing.

Other biomass technologies exist. There are power plants that burn chipped wood alone or that co-fire the chips with natural gas. Two new biomass technologies are under development. One converts biomass to a gas for burning. The other harvests and burns the whole above-ground portion of a tree at once. One of the challenges for all biomass technologies is assuring a reliable biomass fuel supply.

The PSC has determined that potential fuel supplies for environmentally-sound biomass-fired power plants should be used in the following priority order:

1. Wood industry residues—e.g., lumber mill residues and sawdust, furniture manufacturing wastes, pallets, etc.
2. Urban, forest, or agricultural residues—residues resulting from logging cropping, or city tree trimming. Enough logging or cropping residue must be left on the ground to ensure stable soil conditions and appropriate plant nutrient cycling.
3. Woody or herbaceous energy crops—grown sustainably on cropland or in plantations and dedicated to be converted to electricity. Crops showing the most promise in Wisconsin include hybrid poplars, willows, and switchgrass.
4. Natural woodlands—harvesting trees for fuel. This option is the least preferable and most complicated environmentally.

The environmental effects vary with the type of biomass fuel used, although most fuels will have impacts related to transport (truck or rail) and storage. Air emissions from biomass combustion are generally less than those from coal or natural gas. Like coal or natural gas combustion, biomass combustion produces CO_2, an important greenhouse gas. Biomass can also emit lower amounts of NO_x, less ash than coal, and release significantly less toxic material such as mercury. However, growing plants to replace the burned plant material creates a "closed loop" for CO_2 and avoids increasing the overall amount of CO_2 in the air.

Table 1 compares some biomass fuel types with western low-sulfur coal. All of the listed biomass types are available in Wisconsin, but the amount of generation that could be supported by each is unknown.

Table 1 Wood supply compared to coal supply

Fuel Source	Dollars per Million BTU	Environmental Impact of Supply
Primary mill	0.82 to 1.18	Reduces landfilling
Industrial	0.84	Reduces landfilling
Harvesting residues	1.53 to 1.76	Impacts on soil structure and fertility can be minimized by leaving appropriate amounts of residue behind.
Plantation	2.46 to 4.24	Impacts on soil, water, and wildlife can be reduced by best management practices for cropping and harvest.
Forest harvest	1.53 to ?	Many potential impacts of cost increases related to harvesting directly from forest.
Low-sulfur western coal	<1.0	Must be imported to state. Mining, transportation, and storage impacts

Solar Energy

Solar heating

Sunlight can be used to provide energy in three ways. One way is to convert the sunlight into heat using a solar collector. The heat can be used for space heating, water heating, or for certain manufacturing processes. When solar energy replaces electricity in these applications, it can reduce the need for generating capacity. Solar water heaters have been commercially available for many years and thousands have been installed in Wisconsin. The use of solar energy for space heating using "passive" methods has also been popular.

Photovoltaics (PV)

Another way to use solar energy is by converting sunlight directly into electricity through the use of photovoltaic cells, which are grouped together to form a panel. Photovoltaic panels can be used in small groups on rooftops or as part of a substantial system for producing large amounts of electrical power. The amount of energy produced by a photovoltaic system depends upon the amount of sunlight available. The intensity of sunlight varies by season of the year, time of day, and the degree of cloudiness. Currently, PV-generated power is less expensive than conventional power technologies where the load is small or the area is too difficult to serve by electric utilities. Recent breakthroughs may reduce the cost of producing electricity with photovoltaic systems to 10 to 12 cents per kilowatt hour (kWh) or lower. This compares to 3 cents per kWh for fossil fuel-generated power.

While further advances in solar technology are likely, some technologies are available today. As a result of private and government research, photovoltaic systems are becoming more efficient and affordable. Utilities also fund research in these same areas through membership in Electric Power Research Institute (EPRI). With continued improvement, it is likely that photovoltaic technologies will become increasingly cost competitive with conventional generation sources.

Compared to traditional methods of electric generation, photovoltaic systems have few environmental concerns. The primary environmental impacts of large system are visual and can be solved by designing them to blend with their surroundings.

Daylighting

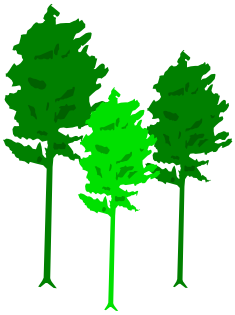
The third way to use the sun is to provide daylighting through appropriate design in residential, commercial, and industrial buildings. The use of natural light reduces energy in two ways. Not only is less energy used for lighting, but the need for summer air conditioning is also reduced since there is less heat generated by electric lights.

Hydroelectricity

The energy from moving water is converted to electricity when water passes by blades similar to those on a ship's propeller. The blades are connected to a rotating shaft which turns a generator to produce electricity. Hydroelectric power plants in Wisconsin range from large, utility-owned dams on major rivers to small locally-owned dams on small streams.

The Wisconsin utilities have identified sites for possible hydroelectric development. Most of these sites involve installing electric generators at existing dams. Although some potential exists for additional hydroelectric development in Wisconsin, public, environmental, and recreational concerns limit the potential for new hydro installations.

Relicensing existing dams is a significant concern at this time. The Federal Energy Regulatory Commission grants licenses to dam operators for periods of up to 50 years. When a dam is reviewed for relicensing, environmental impacts are examined. Dam operations may be restricted to meet new environmental regulations causing a reduction in the amount of electricity produced by the facility.



Hydroelectric power plants produce no air emissions. Their main environmental impacts are related to the flooding of the landscape upstream, changing flows within the stream banks downstream, dividing the stream into separated pools, and damaging or killing young fish. The barriers created by dams constrain fish and other species to specific pools, impacting their ability to survive and reproduce. The turbines have the potential to damage or kill young fish if they are not filtered aside o the upstream side of the dam.

Regulation and the use of Renewable Resources

The federal and state governments can have significant influence on the attractiveness of renewable resources by providing tax advantages for owners of renewable systems. National and state pollution standards, which increase the costs of conventional generation, influence the economics of systems powered by renewable resources. Research and development funded by the federal government and private enterprise can also improve the cost effectiveness of renewable systems.

Additional information regarding wind, solar, and other renewable sources of energy can be obtained from:

- Wisconsin Focus on Energy Program at 1-800-762-7077 or www.focusonenergy.com
- The U.S. Department of Energy (DOE), Energy Efficiency and Renewable Energy (EERE) at 1-877-337-3463 or www.eere.energy.gov

The Role of the PSC

The PSC will be examining potential policy actions that could improve opportunities for generating electricity with renewable resources. The Commission encourages the creation of "green pricing" programs and administers a renewable portfolio standards for electric providers. Utilities are encouraged to consider other environmental benefits as they examine renewable energy sources.

In construction cases, state law requires utilities to consider use of renewable resources to either reduce or eliminate the need for the new facility. In each case, PSC staff performs an analysis to determine to what extent generation from renewable resources can delay the need for the project.

Contacts for Further Information

Paul Helgeson
Public Service Commission of Wisconsin
P.O. Box 7854
Madison, WI 53707-7854
(608) 266-3905
paul.helgeson@psc.state.wi.us

Utility Contacts:

Dave Donovan
Xcel Energy
P.O. Box 8
Eau Claire, WI 54702-0008
(715) 839-4684

John McWilliams
Dairyland Power Cooperative
P.O. Box 817
La Crosse, WI 54601-0817
(608) 787-1464

Jeff Ford
Madison Gas and Electric Company
P.O. Box 1231
Madison, WI 53701-1231
608-252-7387
jford@mge.com

Carl Siegrist
WE Energies
231 W. Michigan St.
Mail Stop P318
Milwaukee, WI 53203
414-221-2183
carl.siegrist@we-energies.com

John Hodgson
Wisconsin Power and Light Company
P.O. Box 192
Madison, WI 53701-0192
608-458-5064

Chip Bircher
Wisconsin Public Service Corporation
P.O. Box 19002
Green Bay, WI 54307-9002
920-433-5518
cbircher@wpsr.com

Gerald Anderson
Superior Water Light and Power Company
P.O. Box 519
Superior, WI 54880-0519
715-394-2222

Jake Oelke
Wisconsin Public Power, Inc.
P.O. Box 44
Sun Prairie, WI 53590
608-837-2653
joelke@wppisys.org

PSC Overview Series

The Public Service Commission has prepared other Overviews for important electric issues. These brochures can be obtained by phoning the PSC at (608) 261-5481 or visiting our web site at http://psc.wi.gov.

- Common Power Plant Siting Criteria
- Electric Energy Efficiency
- Electric Power Plants
- Electric Transmission Lines
- EMF -Electric and Magnetic Fields
- Environmental Impacts of Electric Transmission Lines
- Nuclear Power Plant Decommissioning and Radioactive Waste Disposal
- Power Plants Approval Process
- Public Hearing Guide, Electric Construction Projects
- Right-of-Way and Easements for Electric Facility Construction
- Transmission Line Approval Process
- Underground Electric Transmission Lines

The Public Service Commission does not discriminate on the basis of disability in the provision of programs, services, or employment. If you are speech, hearing, or visually impaired and need assistance, call (608) 266-5481 or TTY (608) 267-1479. We will try to find another way to get the information to you in a usable form.

Public Service Commission of Wisconsin
Gas and Energy Division
610 N. Whitney Way
P.O. Box 7854
Madison, WI 53707-7854

General Information: 608-266-5481
TTY: 608-267-1479
Fax: 608-266-3957
http://psc.wi.gov

6012B August 2004